Revised Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health for PCBs

Cancer Effects: Linear Low Dose Extrapolations

$$AWQC = RSD\left[\frac{BW}{DI + \sum_{i=2}^{4}\left(FI_i \bullet BAF_i\right)}\right]$$

where:

AWQC = Ambient Water Quality Criterion (mg/l)
RSD = Risk-specific Dose (mg/KG-day) such as 10^{-6}
BW = Body weight (KG)
DI = Drinking water intake per day (default = 2 Liters)
FI_i = Fish intake at trophic level i (where i = 1, 2, 3, 4)
BAF_i = Bioaccumulation Factor at trophic level i

Bioaccumulation Factors (BAF_i)

1. Procedure #1 of the four procedures presented in the guidance for nonionic organic chemicals is appropriate for PCBs and chlorinated pesticides since these chemicals are moderately to highly hydrophobic, and have low or unknown rates of metabolism by aquatic biota.

2. Select the procedure to be used to calculate the baseline BAF_i:

    a. BAF is obtained from field studies.
    b. BAF is predicted from an acceptable field-measured BSAF (Biota-Sediment Accumulation Factor)
    c. BAF is predicted from an acceptable Lab-measured BCF and a food chain multiplier (FCM)
    d. BAF is predicted from an acceptable octanol-water partition coefficient and an FCM.

Steps in Deriving the BAF

Step 1: Select BAF Procedure

BAFs will be determined from field data. This procedure is recommended for PCBs, chlorinated pesticides and dioxins.

Step 2: Calculate Individual Baseline BAFs

This involves normalizing the field-measured BAFs which are based upon total concentrations in fish tissue and water by the lipid content of the study organisms and the freely dissolved concentrations of the chemical in the ambient water.

These individual baseline BAFs should be calculated for each species at each trophic level.

$$Baseline\ BAF_{\ell}^{fd} = \left[\frac{Measured\ BAF_{T}^{t}}{f_{fd}} - 1 \right] \times \frac{1}{f_{\ell}}$$

where:

Baseline BAF_l^{fd} =	BAF expressed on a freely-dissolved and lipid-normalized basis.
Measured BAF_T^t =	BAF based on the total concentration in fish tissue and water.
f_ℓ =	Fraction of tissue that is lipid.
f_{fd} =	Fraction of the total chemical that is freely dissolved in the ambient water.

The fraction that is freely dissolved (f_{fd}) is that portion of the chemical that is not bound to particulate organic carbon or dissolved organic carbon. This fraction can be calculated using the K_{ow} for the chemical, and the POC and DOC concentrations.

Step 3: Select Final Baseline BAFs

a. Calculate species-mean baseline Baseline BAF_l^{fd}s - use geometric mean.

b. Calculate trophic-level-mean baseline Baseline BAF_l^{fd}s - use geometric mean.

c. Select the final Baseline BAF_l^{fd} for each trophic level.

Step 4: Calculate National BAFs - in this step the final Baseline BAF_l^{fd} for each trophic level are converted to a BAF that reflects the conditions to which the water quality criteria applies.

The following statement appears on page 5-43 of the guidance:

For use in criteria development, these BAFs [the final Baseline BAF_l^{fd}s] *should be converted back to values based upon the total concentration in the water to be consistent with monitored water column and effluent concentrations....*

Formula:

$$National\ BAF_{(TL\ n)} = \left[\left(Final\ Baseline\ BAF_{\ell}^{fd}\right)_{TL\ n} \times \left(f_{\ell}\right)_{TL\ n} + 1\right] \times f_{fd}$$

where:

National $BAF_{(TL\ n)}$ =	BAF for trophic level "n"
Final Baseline $BAF_{l}^{fd}{}_{(TL\ n)}$ =	Final trophic-level-mean baseline BAF expressed on a freely-dissolved and lipid-normalized basis.
$f_{\ell\ (TL\ n)}$ =	Fraction of tissue that is lipid for trophic level "n".
f_{fd} =	Fraction of the total chemical that is freely dissolved in the ambient water.

These National $BAF_{(TL\ n)}$ are then used in the formula for deriving the human health water quality criteria (AWQC).